



CONDUCTOR AND CONDUIT (OR RACEWAY) SCHEDULE

SYM.	CIRCUIT	MAX. CURR. (A)	LOCATION	TYPE	CONDUCTOR	COND. MIN. SIZE (AWG)	MAT.	CUR. CAR. COND.	MAX. CONDUCT. CUR. (A)	TEMP. COR. FACTOR	CONDUIT ADJ. FACT.	MAX. COND. CUR. (CORR.) (A)	WET TEMP. RATING (deg. C)	CONDUIT TYPE	CONDUIT SIZE (in.)	OCPD TYPE	OCPD (A)
1	MANUFACTURER CABLE	12	Free air	TC-ER	L1/L2, N, EGC	12, 12, 12	CU	-	40	0.91	1	36.40	90	-	-	-	-
2	PV MICROINVERTER AC SOURCES	12	Conduit/Int.	THWN-2	L1/L2, N, EGC	10, 10, 10	CU	6	40	0.91	0.80	29.12	90	Metallic	3/4	Cir. Breaker	15



Company

Name	Octopus inc.
Address	1234 Yellow Sub Ln.
City	Cocoa
State	FL
Zip Code	32780
Country	USA

Module

Manufacturer	SolarWorld
Model	Sunmodule Plus SW300 Mono
Nameplate Power Rating	300W
Cell Type	Monocrystalline
Total Number Cells	60
Pmp	300 W
Voc	40.10 V
Isc	10.23 A
Vmp	32.60 V
Vnoct	30.20 V
Vlow	30.18 V
Imp	9.57 A
Max Series Fuse	15 A
Max System Voltage	600 V
TC Voc Percent	-0.30
Fire Type	2
Eff	17.89

Array

Num Of Modules	22
Num Of Strings	2
Smallest String	10
Largest String	12
Max Temp	36 C
Min Temp	-9 C
Code Defined Voltage Limit	600 V
Voltage Correction Factor	1.14
Pmp	6600 W

Inverter

Manufacturer	Enphase
Model	M250-60-2LL-S22/S25
MPPT Channels	1
Vmax	48 V
Vstart	22 V
MPPT Min.	27 V
MPPT Max.	39 V
Max. Isc per MPPT	15 A
Voltage Range Min	16 V
Voltage Range Max	48 V
Nominal AC Output Power	240 W
Max AC Output Current	1 A
Arc-Fault Circuit Protection	Yes
GFDI	Yes

Interconnection

Grid Voltage	240 VAC
Busbar Rating	225 A
Supply OCPD Rating	200 A
Inverter OCPD Device Sum	30 A
Inverter Output Cur Sum	24 A
Inverter Max Cur. * 125%	15 A
Bussbar Loads	150 A
705.12(D)(2)(3)(a)	No
705.12(D)(2)(3)(b)	Yes
705.12(D)(2)(3)(c)	Yes
705.12(D)(2)(3)	PASS



ELECTRICAL NOTES

- 1.) CONTRACTOR IS RESPONSIBLE FOR COMPLYING WITH ALL LOCAL OR NATIONAL CODE REQUIREMENTS AND EQUIPMENT INSTALLATION INSTRUCTIONS.
- 2.) ALL COMPONENTS MUST BE GROUNDED PER NEC 690.43 AND ACCORDING TO THE MANUFACTURER'S INSTRUCTIONS.
- 3.) ALL EQUIPMENT TO BE LISTED BY UL OR OTHER NRTL, AND LABELED FOR ITS APPLICATION PER NEC 690.4(D).
- 4.) ALL CONDUCTORS SHALL BE COPPER, RATED FOR 600 V AND 90 DEGREE C WET ENVIRONMENT.
- 5.) WIRING, CONDUIT, AND RACEWAYS MOUNTED ON ROOFTOPS SHALL BE ROUTED DIRECTLY TO, AND LOCATED AS CLOSE AS POSSIBLE TO THE NEAREST RIDGE, HIP, OR VALLEY.
- 6.) WORKING CLEARANCES AROUND ALL NEW AND EXISTING ELECTRICAL EQUIPMENT SHALL COMPLY WITH NEC 110.26.
- 7.) CONTRACTOR SHALL FURNISH ALL NECESSARY OUTLETS, SUPPORTS, FITTINGS AND ACCESSORIES TO FULFILL APPLICABLE CODES AND STANDARDS.
- 8.) WHERE SIZES OF JUNCTION BOXES, RACEWAYS, AND CONDUITS ARE NOT SPECIFIED, THE CONTRACTOR SHALL SIZE THEM ACCORDINGLY.
- 9.) ALL WIRE TERMINATIONS SHALL BE APPROPRIATELY LABELED AND READILY ACCESSIBLE.
- 10.) IF APPLICABLE, MODULE GROUNDING LUGS MUST BE INSTALLED AT THE MARKED GROUNDING LUG HOLES PER THE MANUFACTURER' INSTALLATION REQUIREMENTS
- 11.) AS INDICATED BY DESIGN, OTHER NRTL LISTED MODULE GROUNDING DEVICES MAY BE USED IN PLACE OF STANDARD GROUNDING LUGS AS SHOWN IN MANUFACTURER DOCUMENTATION, AND APPROVED BY THE AHJ.
- 12.) CONDUIT AND WIRE SPECIFICATIONS ARE BASED ON A MINIMUM CODE REQUIREMENTS AND ARE NOT MEANT TO LIMIT UP-SIZING AS REQUIRED BY FIELD CONDITIONS.
- 13.) THE AMBIENT TEMPERATURE CORRECTION FACTORS ARE BASED ON 30 DEGREE C
- 14.) THE UTILITY WILL NEED TO CHANGE THE METER TO ONE THAT IS APPROVED FOR NET METERING PER FBC 107

EQUIPMENT LOCATIONS

- 1.) ALL EQUIPMENT SHALL MEET MINIMUM SETBACKS AS REQUIRED BY (NEC 110.26)
- 2.) EQUIPMENT INSTALLED IN DIRECT SUNLIGHT MUST BE RATED FOR EXPECTED OPERATING TEMPERATURE AS SPECIFIED BY (NEC 690.31(A-B)) AND (NEC TABLE 310.15(B)(2)(C))
- 3.) ADDITIONAL AC DISCONNECTS SHALL BE PROVIDED WHERE THE INVERTER IS NOT ADJACENT TO THE UTILITY AC DISCONNECT, OR NOT WITHIN SIGHT OF THE UTILITY AC DISCONNECT.



Module Specifications From Database			Inverter Specifications From Database		
Description	Symbol	Value	Description	Symbol	Value
FSEC approved	module.fsec_approved	Yes	Is inverter tranformerless	inverter.tranformerless	Yes
Maximum power @ STC (W)	module.pmp	300 W	Maximum dc voltage, Vmax,inv (V)	inverter.vmax	48 V
Open-circuit voltage @ STC (V)	module.voc	40.10 V	MPPT minimum dc operating voltage (V)	inverter.mppt_min	27 V
Short-circuit current @ STC (A)	module.isc	10.23 A	MPPT maximum operating voltage (V)	inverter.mppt_max	39 V
Maximum power voltage @ STC (V)	module.vmp	32.60 V	Min. dc operating voltage (V)	inverter.voltage_range_min	16 V
Maximum power current @ STC (A)	module.imp	9.57 A	Min. dc start voltage (V)	inverter.vstart	22 V
Number of cells	module.total_number_cells	60 -	Number of inverter inputs or MPP trackers	inverter.mppt_channels	1 A
Maximum overcurrent device rating (A)	module.max_series_fuse	15 A	Maximum OCPD Rating (A)	inverter.max_ac_ocpd	20 A
Maximum system voltage rating (V)	module.max_system_v	600 V	Maximum DC short circuit current per inverter input or MPPT	inverter.isc_channel	15 A
Nameplate rating	module.nameplaterating	300 W	Maximum DC operating current per inverter input or MPPT	inverter.imax_channel	-
			Grid voltage	inverter.grid_voltage	240 V
			Maximum DC input power	inverter.max_ac_output_current	1 W
			Maximum DC input power	inverter.max_ac_output_current	1 W
			Maximum units per branch	inverter.max_unitsperbranch	16 -
			Minimum units per branch	inverter.min_unitsperbranch	1 -
			Minimum panel wattage	inverter.min_panel_wattage	210 W
			Maximum panel wattage	inverter.max_panel_wattage	350 W
			Maximum number of cells per panel	inverter.max_module_cells	60 -
			Maximum watts per string	inverter.max_watts_per_branch	-
Constants					
Description	Symbol	Value			
2% Maximum Temperature	array.max_temp	36 C			
Extreme Annual Mean Minimum Design Dry Bulb Temperature	array.min_temp	-9 C			
Maximum Voltage Rating?	array.code_limit_max_voltage	600 V			
Voltage Correction Factor	array.voltage_correction_factor	1.14			
			Database Calculations		
DESCRIPTION	SYMBOL	CALCULATION	VALUE		
If max_ac_ocpd is not provided by the manufacturer, it is calculated as follows:					
Inverter AC OCPD max	inverter.AC_OCPD_max	max_ac_output_current * 1.25	20.00 A		
			Microinverter Calculations		
DESCRIPTION	SYMBOL	CALCULATION	RESULT		
Maximum source/branch power	source.max_power	module.pmp * array.largest_string	3600.00 W		
Maximum source/branch current	source.current	inverter.nominal_ac_output_power / 240 * array.largest_string	12.00 A		
Maximum array power	array.pmp	array.num_of_modules * module.pmp	6600.00 W		
Array total power exceeds 10kW	-	error_check.power_check_array = array.pmp > 10000	PASS		
The system has too many inverters per branch circuit.	-	array.largest_string > inverter.max_unitsperbranch	PASS		
The system has too many inverters per branch circuit.	-	array.smallest_string < inverter.min_unitsperbranch	PASS		
The branch circuit power limit has exceeded the manufacturer's limit.	-	source.max_power > inverter.max_watts_per_branch	PASS		
Module voltage does not meet inverter minimum.	-	module.vmp < inverter.mppt_min	PASS		
Module voltage exceeds inverter maximum.	-	module.vmp > inverter.mppt_max	PASS		
Module current exceeds inverter maximum.	-	module.isc > inverter.isc_channel	PASS		
Module cell count exceeds the maximum allowed by the inverter.	-	module.total_number_cells > inverter.max_module_cells	PASS		
			Interconnection Calculations		
DESCRIPTION	SYMBOL	CALCULATION	RESULT		
Sum of inverter output current.	intercon.inverter_output_cur_sum	source.current * array.num_of_strings	24.00 A		
Sum of inverter OCPD.	intercon.inverter_ocpd_dev_sum	inverter.OCPD * array.num_of_strings	30.00 A		
Maximum AC current.	intercon.max_ac_current	source.current	12.00 A		
Maximum AC current (125%)	intercon.max_ac_current_125	intercon.max_ac_current * 1.25	15.00 A		
At least one of the following checks must not fail:					
(1) The sum of 125 percent of the inverter(s) output circuit current and the rating of the overcurrent device protecting the busbar exceeded the ampacity of the busbar.					
(2) The sum of 125 percent of the inverter(s) output circuit current and the rating of the overcurrent device protecting the busbar exceeded 120 percent of the ampacity of the busbar.					
(3) The sum of the ampere ratings of all overcurrent devices on panelboards exceeded the ampacity of the busbar.					
705.12(D)(2)(3)(a)	-	((intercon.inverter_output_cur_sum * 1.25) + intercon.supply_ocpd_rating) <= intercon.bussbar_rating	No		
705.12(D)(2)(3)(b)	-	(intercon.inverter_output_cur_sum * 1.25) + intercon.supply_ocpd_rating <= intercon.bussbar_rating * 1.2	Yes		
705.12(D)(2)(3)(c)	-	(intercon.inverter_ocpd_dev_sum + intercon.load_breaker_total) <= intercon.bussbar_rating	Yes		
The busbar is not compliant.	-	and(intercon.check_1, intercon.check_2, intercon.check_3)	PASS		
Busbar main OCPD exceeds the rating of the busbar.	-	intercon.supply_ocpd_rating > intercon.bussbar_rating	PASS		
			D C Circuit Calculations		
DESCRIPTION	SYMBOL	CALCULATION			
Maximum voltage	circuit.max_voltage	source.voc			
Maximum current	circuit.max_current	array.combined_isc			
Total current carrying conductors	circuit.total_cc_conductors	(array.num_of_strings * 2)			
Total conductors	circuit.total_conductor	(array.num_of_strings * 2) + 1			
			A C Circuit Calculations		
DESCRIPTION	SYMBOL	CALCULATION			
Maximum voltage	circuit.max_voltage	inverter.grid_voltage			
Maximum current	circuit.max_current	inverter.max_ac_output_current			
Total current carrying conductors	circuit.total_cc_conductors	inverter.num_conductors - 1			
Total conductors	circuit.total_conductor	inverter.num_conductors			
			Circuit Calculations		
DESCRIPTION	SYMBOL	CALCULATION			
Temperature adder	circuit.temp_adder	lookup module.array_offset_from_roof in NEC TABLE 310.15(B)(3)(c)			
Max. conductor temoerature	circuit.max_conductor_temp	array.max_temp + circuit.temp_adder			
Temperature correction factor	circuit.temp_correction_factor	lookup circuit.max_conductor_temp in NEC TABLE 310.15(B)(2)(a)			
Conduit adjustment factor	circuit.conductors_adj_factor	lookup circuit.total_cc_conductors in NEC TABLE 310.15(B)(3)(a)			
Conduit adjustment factor	circuit.conductors_adj_factor	if circuit.location = "Free air", circuit.conductors_adj_factor = 1			



Florida
Solar
Energy
Center

PV System Design. Created: 2018-03-27
Based on 2014 NEC & 6th Edition (2017) FBC.
Produced by the Solar Plans Designer.

Registered by: Octopus inc.
1234 Yellow Sub Ln.
Cocoa, FL 32780, USA

System size: 22 modules, 6.6kW DC, 5.3kW AC
Inverter: Enphase, M250-60-2LL-S22/S25
Module(s): SolarWorld, Sunmodule Plus SW300 Mono

Calculations

G-002

WARNING

ELECTRIC SHOCK HAZARD IF
A GROUND FAULT IS INDICATED
NORMALLY GROUNDED
CONDUCTORS MAY BE
UNGROUND AND ENERGIZED

LABEL LOCATION:
PV DISCONNECTS

PER CODE:
NEC 690.5(C)

MAXIMUM AC
OPERATING CURRENT 13 A
MAXIMUM AC
OPERATING VOLTAGE 240 V

LABEL LOCATION:
AC DISCONNECT,
POINT OF INTERCONNECTION

PER CODE:
NEC 690.54

MAXIMUM AC
OPERATING CURRENT 15 A
MAXIMUM AC
OPERATING VOLTAGE 240 V

LABEL LOCATION:
AC DISCONNECT,
POINT OF INTERCONNECTION

PER CODE:
NEC 690.54

PHOTOVOLTAIC POINT OF
INTERCONNECTION
WARNING: ELECTRIC SHOCK
HAZARD. DO NOT TOUCH
TERMINALS. TERMINALS ON
BOTH THE LINE AND LOAD SIDES
MAY BE ENERGIZED IN THE OPEN
POSITION. FOR SERVICE
DE-ENERGIZE BOTH SOURCE
AND MAIN BREAKER.
PV POWER SOURCE

MAXIMUM AC
OPERATING CURRENT 28 A
MAXIMUM AC
OPERATING VOLTAGE 240 V

LABEL LOCATION:
AC DISCONNECT,
POINT OF INTERCONNECTION

PER CODE:
NEC 690.17(4)
NEC 690.54

CAUTION

DUAL POWER SOURCE
SECOND SOURCE IS
PHOTOVOLTAIC SYSTEM

LABEL LOCATION:
POINT OF INTERCONNECTION

PER CODE:
NEC 705.12(D)(3)

PHOTOVOLTAIC AC DISCONNECT

LABEL LOCATION:
AC DISCONNECT

PER CODE:
NEC 690.14(C)(2)

WARNING

ELECTRIC SHOCK HAZARD
DO NOT TOUCH TERMINALS
TERMINALS ON BOTH LINE AND
LOAD SIDES MAY BE ENERGIZED
IN THE OPEN POSITION

LABEL LOCATION:
AC DISCONNECT,
POINT OF INTERCON.

PER CODE:
NEC 690.17(E)

WARNING

INVERTER OUTPUT
CONNECTION
DO NOT RELOCATE
THIS OVERCURRENT
DEVICE

LABEL LOCATION:
POINT OF INTERCON.

PER CODE:
NEC 705.12(D)(2)(3)(b)

LABEL NOTES

- 1.) ADHESIVE FASTENED SIGNS MAY BE ACCEPTABLE IF PROPERLY ADHERED.
- 2.) VINYL SIGNS SHALL BE WEATHER RESISTANT [IFC 605.11.1.3]. REFLECTIVE WEATHER RESISTANT MATERIAL SUITABLE FOR THE ENVIRONMENT.
- 3.) PROVIDE A PERMANENT PLAQUE OR DIRECTORY SHOWING ALL ELECTRIC POWER SOURCES ON THE PREMISES AT SERVICE ENTRANCE, PER NEC 705.10.
- 4.) USA ARIAL OR SIMILAR FONT, NON-BOLD.

* MARKING CONTENT AND FORMAT REQUIREMENTS

- RED BACKGROUND
- WHITE LETTERING
- MINIMUM 3/8" LETTER HEIGHT
- ALL CAPITAL LETTERS



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Label Requirements

L-001

SYSTEM DESIGN REQUIREMENTS

General Information

User-specified equipment and design elements shall be compliant with current adopted codes and standards, including 2017 FBC, 2014 NEC, 6th Ed FFPC (NFPA 1) and ASCE 7-10.

All equipment shall be listed and installed in accordance with manufacturer's instructions.

All PV systems and associated equipment shall be installed only by licensed contractors and qualified persons.

Comments / Referened Standards

2014 NEC, 2017 FBC, FFPC, ASCE7-10.

NEC 110.3(B)

NEC 690.4(E), FS Ch 489

Disclaimers

User assumes full responsibility for providing accurate and valid input data.

Program results verify minimum requirements for code compliance only.

System performance and design optimization is not considered.

This program does not evaluate impact from shading on arrays.

This program may not consider all aspects of product installation manuals for listed equipment.

AHJs verify compliance with 110.3(B), product installation manuals (and specifications) shall be included in permitting documents for reference.

Limitations

System Restrictions

Simple interactive PV systems only, no battery-based systems.

Program addresses string inverter systems only.

See NEC 690.2 and "Definitions" tab for standard definitions for PV system circuits used in this document.

PV systems using AC modules, microinverters and arrays using dc electronics at the module level are not considered in this initial version. Additional algorithms will be added for systems using module-level electronics (ac modules, microinverters and dc-dc converters).

Building Restrictions

Risk Caterory II structures, single-family residential buildings only.

Installed only on buildings with 2x4 pre-engineered truss systems, 24" OC spacing.

Minimum electrical service requirements 150 A @ 240 V, split-phase.

Interconnections to load side of service disconnecting means only.

Limits structural calculations required

Limits structural calculations required

Limits electrical configurations

Limits electrical configurations

Equipment Restrictions

These restrictions narrow the scope of design complexity and the code calculations required.

Inverters

Shall be listed to UL1741 standard, and identified for use with ungrounded PV arrays.

690.4(D) requires inverters listed and identified for interactive PV systems. 690.35(G) requires inverters used in systems with ungrounded photovoltaic source and output circuits to be listed for the purpose.

Shall have integral dc disconnect, source circuit combiner

This limitation assumes all PV source circuits are terminated/parallel at the inverter, and no PV output circuit calculations required.

Shall have integral ground-fault protection

690.5 and 690.35(C) require ground-fault protection. PV systems requiring ground-fault protection devices are permitted to have the single-point grounding connection made inside the ground-fault protection equipment or inside the utility-interactive inverter and additional external bonding connections are not permitted. Connections are to be made in accordance with markings on the equipment or in the installation instructions.

Shall have integral dc arc-fault protection per UL1699B

690.11 (2011) requires dc arc-fault protection for PV arrays on buildings operating over 80 V.

Shall be located in a readily accessible location inside or outside a building

Avoids special labeling and disconnect requirements for inverters installed in not readily accessible locations, such as attics or on rooftops per 690.14(D).

Shall be limited to maximum 56 A rated continuous ac output current

This limitation is based on the maximum inverter overcurrent device rating permitted in a residential load center with 200 A OCPD and 225 A busbar rating for load side interconnections.

PV Modules

Shall be listed to UL1703 standard

Required by 690.4(D), 110.3(B)

Flat-plate crystalline silicon modules only

Industry standard

Minimum Class C fire rating

For installation on rooftops, must have equa to or greater fire classification than roofing materials.

Load ratings shall be provided in manufacturer's specifications

Required for wind calculations.

Other BOS

Racking systems shall be listed to UL 2703 standard and have integrated equipment grounding

Industry standard. Proper bonding between structural elements required, must use manufacturer approved bonding jumpers and equipment bonding washers as applicable, installed according to manufacturer's instructions. 250.136(A) permits bonded metal racking materials to be used for the equipment grounding conductor, and transition to an appropriate size conductor to be run with the PV output circuits. 690.43(C) also permits structures to be used as the equipment grounding conductor. Devices listed and identified for grounding the metallic frames of PV modules or other equipment shall be permitted to bond the exposed metal surfaces or other equipment to mounting structures. Metallic mounting structures, other than building steel, used for grounding purposes shall be identified as equipment-grounding conductors or shall have identified bonding jumpers or devices connected between the separate metallic sections and shall be bonded to the grounding system. 690.43(F) Requires equipment grounding conductors for the PV array and structure (where installed) to be contained within the same raceway or cable or otherwise run with the PV array circuit conductors when those circuit conductors leave the vicinity of the PV array.

Shall use minimum 6 AWG CU equipment grounding conductors where exposed, smaller size EGCs shall be installed in raceways

Does not require physical protection for exposed EGC at array per 690.46 and 250.120(C).

PV module frames are bonded to metal racking with listed equipment bonding washers or piercing clamps.

690.43(D) permits devicesand systems used for mounting PV modules that are also used to provide grounding of the module frames shall be identified for the purpose of grounding PV modules.

Listed PV wire shall be used for all exposed single-conductor PV module interconnections

Industry standard, USE-2 permitted by 690.31(B) is not permitted as exposed single-conductor for ungrounded arrays per 690.35(D).

Listed PV fuses shall be used for all PV source circuits, if required

PV-rated fuses do not normally require temperature de-rating.

All source combiner boxes listed to UL 1741 standard

Shall have proper NEMA rating, number of poles, appropriate current and voltage ratings, fuses for both positive and negative circuits (required for ungronded arrays), and be installed according to manufacturer's instructions.

Other junction boxes and enclosures

Have appropriate ratings and be installed according to manufacturer's instructions.

All electrical terminals in dc circuits rated for 90°C

Allows 90°C rated conductor ampacities to be used from Tables 310.15(B)(16) and (17). This includes dc combiner boxes and any installer supplied splices or terminations. Inverter ac output circuits used 75 C ampacity based on connection to standard circuit breakers with 75 C terminals.